The Changing Dynamics of a Universe in Transition

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Abstract

It is shown in the present work that the distorted space model of matter can describe a universe transitioning between conception and an open-ended finality. We use the verbiage "distorted" to communicate the concept of "energetic-manifold-warping" and to distinguish "spatial-warping" from "classical matter-warping", although the concept of "matter" is in fact, in the present "distorted-geometry" context, the "geometric distortion energy" of the spatial manifold itself without a classical "matter stress-energy source". An energy conserving alternative to black-body radiation-emission structural-modeling is manifest as an energetically unstable Universe (**an originally stable but subsequently collapsing state, followed by an explosive expansion, thereby exhibiting an energy-creation process of one day!**). The energy transition dynamics are described for a spherical, gravitational, and electromagnetic, geometrically based mimic of matter existing at quantitative measures of a size

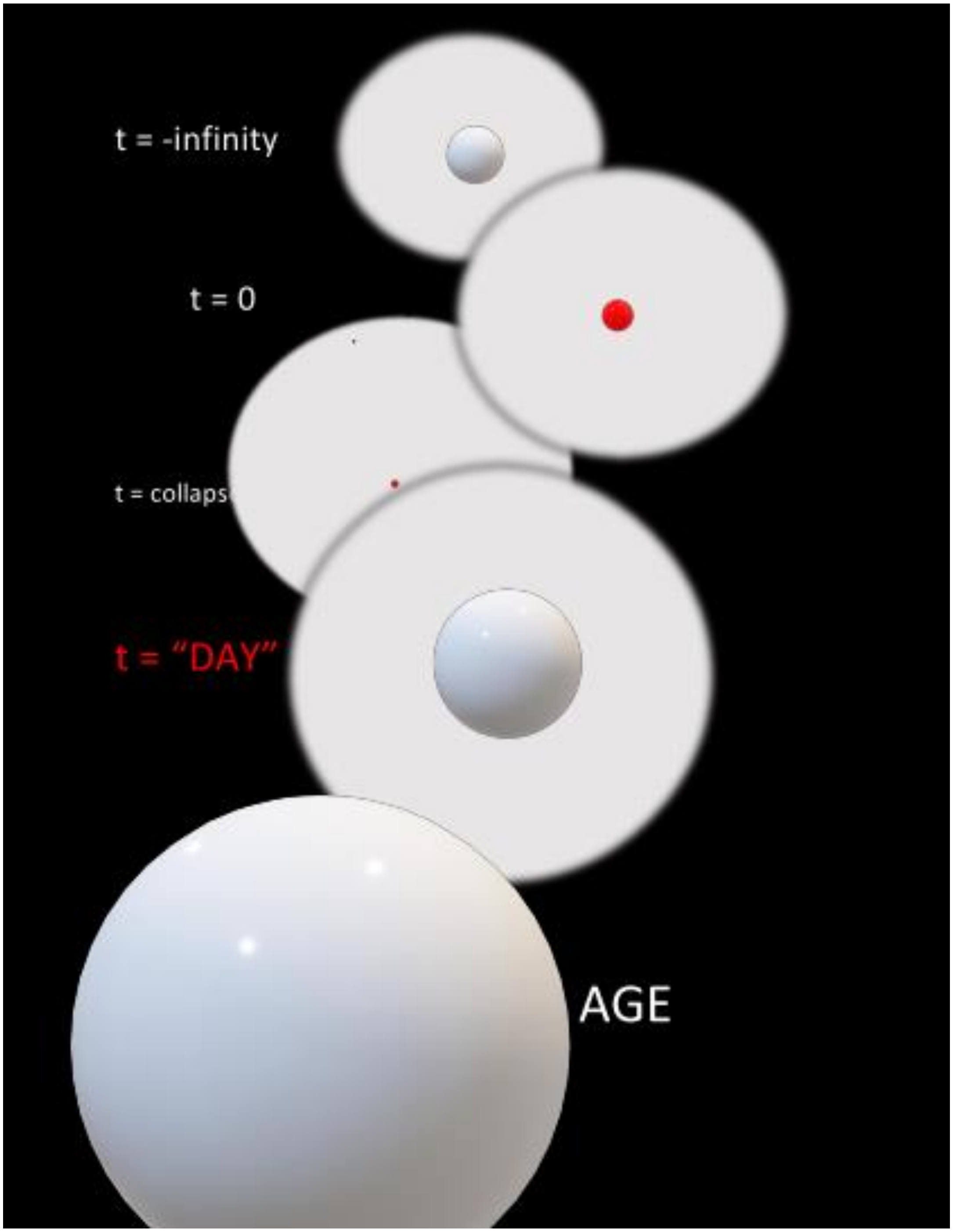
challenging observation, that is, at a calculated **Universe (gravitational body) radius $\equiv 2\kappa_G U = 1.27(10)^{26}$ meters** and **$U_{grav} = U_{EM} = 7.7\ (10)^{69}$ Joules. The Universe (electromagnetic body) radius is calculated at = $1.3(10)^{13}$ meters.**

We have modeled the structure with a composite, two-component, geometric-coupling constant and initial structural conditions representing Friedmann**'s critical density, ρ_critical energy-density ($8.898(10)^{-10}$ J/m^3) for the gravitational energy-density** and **ρ_electron ($8.7(10)^{29}$ J/m^3) = the ρ_critical energy-density for the geometric-electromagnetic extremum**; the **geometric extrema** are **curvature and energy-density extrema**. A collapsing initial-phase-1 state, posited as a Friedmann-defined, **distorted-geometry (DG)** configuration with two equal-energy species or energy-density states, transitions electromagnetically, via an intermediate "mediator or force carrier" state (a W^-boson structure in beta-decay), to a final 3-component state (ala a mimic of the beta decay transition process).

1. Introduction

It is shown in the present work that the distorted-space model of matter can describe a universe transitioning between conception and an open-ended finality. We use the verbiage "distorted" to communicate the concept of "energetic-manifold-warping" and to distinguish "spatial-warping" from "classical matter-warping", although the concept of "matter" is in fact, in the present "distorted-geometry" context, the

“geometric distortion energy” of the spatial manifold itself without a classical “matter stress-energy source”. An artistic rendering of such a phenomenon is depicted here and mathematically graphed in Figures 1-6.



Time-indices are indicated in the border areas. This is a classical attempt to show a "time changing" series of events with a "static" "artistic" display of figures. The "top" figure (labelled “t = -infinity”), represents the earliest time with the larger sphere representing the "gravitational" distribution of Universe energy, while the smaller inner sphere represents the "electromagnetic" distribution of Universe energy. The construction of the “electromagnetic-energy” sphere results from utilizing the “distorted geometry (DG)” composite “geometry-to-energy” coupling-constant, a latter-day construct for describing ANY energy-bearing structure; you can't describe an electron without this energy.

The timeline **starts** with the inner electromagnetic sphere (radius = $1.3(10)^{13}$ meters collapsing to a radius so small that you cannot **really** show it on such an artistic rendering (radius = $1.5(10)^{6}$ meters), where the next time-evolving spheres (labelled t = 0 and t = collapse) are intended to represent this collapsing process.

Then, the inner (next) sphere **explodes** (expands); this is the stage where the definition of the **day** occurs. It is determined from the basic Distorted Geometry model of matter which has been applied to describe the electron, the muon, the boson and radiation, all the building blocks of matter and now at the dimensions of the Universe. Finally, the 5-th sphere rendering shows the condition where the inner sphere has expanded to the diameter of the outer sphere, a condition representing the AGE of the Universe at a diameter of $1.27(10)^{26}$ meters!

The undertaking to communicate this development really requires a "video" to show a "time" development.

We use the verbiage “distorted” to communicate the concept of “energetic-manifold-warping” and to distinguish “spatial-warping” from “classical matter-warping”, although the concept of “matter” is in fact, in the present “distorted-geometry” context, the “geometric distortion energy” of the spatial manifold itself without a classical “matter stress-energy source”. An energy conserving alternative to black-body radiation-emission structural-modeling is manifest as an energetically unstable Universe (an originally stable but subsequently collapsing state followed by an explosive expansion). The energy transition dynamics are described for a spherical, gravitational, and electromagnetic, geometrically-based mimic of matter existing at quantitative measures of a size challenging observation, that is, at a calculated **Universe (gravitational body) radius ≡ $2\kappa_G U = 1.27(10)^{26}$ meters** and **Ugrav = $7.7\ (10)^{69}$ Joules**. We have modeled the structure with a composite, two-component, geometric-coupling-constant, with all states defined by the composite coupling-constant $\kappa = \kappa_G + \kappa_{EM}$ where $\kappa_G = G\,c^{-4}$ and $\kappa_{EM} = \alpha\,\frac{\hbar c}{2}\left(\frac{Q}{U_{EM}}\right)^2$, and initial structural conditions representing **Friedmann’s ρ_critical energy-density ($8.898(10)^{-10}$ J/m^3) for the gravitational energy-density** and **ρ_electron ($8.7(10)^{29}$ J/m^3) = the ρ_critical energy-density for the geometric-electromagnetic extremum**; the geometric extrema are curvature and energy-density extrema. For the

geometric structural-mimic of the electron; the electron-radius ≡ Relec = 2KQ Q^2/U where Qelec =1, Uelec = me c^2 and KQ = α(fine structure)$\hbar/2$. Classically, the electron is an "electromagnetic" structure characterized with "electromagnetic" descriptors, however in this "distorted or warped geometry" modeling (possible by virtue of a solution to the Riemannian geometric equations, after ascribing a material quality to localized "distorted or warped" regions of the geometric manifold), these electromagnetic descriptors are understood in geometric terms such as the magnitudes of the r^{-6}, r^{-4} and r^{-n} structural features of the energy-density elements. Also, the geometric equations giving rise to the energy-density descriptors are non-linear and coupled so that the classical models of independent constructs are not appropriate in this modeling. A particularly important feature which improves on the classical r^{-2} or r^{-3} description of "forces" or "energy densities or pressures" is the absence of "singularities", that is, there are no infinities at the geometric origins of the distortion features.

This Universe energy-defined structure contracts and expands at velocity c. The "structural mimic" is an "energy-density magnitude-simulation", that is with ρG_Universe-minimum ≡ ρG_electron = ρG_black-hole-minimum and ρG_Universe-maximum ≡ ρG_boson = ρG_black-hole-maximum; these are nuclear or fundamental-particle determined, distorted-geometry(DG)-based, geometric-curvature extrema which are basic to geometric fundamental particle and primordial gravitational black-hole characterization. When the post-collapse energy-densities of

the Universe-structural-components are within this extrema-defined energy-density range, all energy-density defined gravitational and electromagnetic structures can be generated (created).

A collapsing initial-phase-1 state, posited as a Friedmann-defined, distorted-geometry (DG) configuration with two equal-energy species or energy-density states, electromagnetically transitions, via an intermediate "mediator" state (a W^-boson structure in beta-decay), to a final 3-component state (ala a mimic of the beta-decay transition process), with all states defined by the composite coupling-constant $\kappa = \kappa_G + \kappa_{EM}$ where $\kappa_G = G\, c^{-4}$ and $\kappa_{EM} = \alpha \frac{\hbar c}{2} \left(\frac{Q}{U_{EM}}\right)^2$. The constant-U condition is posited via the time dependency equations,

$$R_{univ} = 2(\kappa_G + \kappa_{EM})U \quad \text{and}$$

$$dR/dt = 2(\kappa_G\, dU/dt + \kappa_{EM}\, dU/dt + U\, d\kappa_{EM}/dt) \quad \text{with } dU/dt = 0.$$

The originally stable electromagnetic (EM) initial state, one of the two species, is **perturbed and initiated to collapse** to an energy-density represented by the posited DG-geometric-maximum-curvature limit of the geometric manifold. The time changing features of the electromagnetic sphere are the "charge quantity Q" and the collapsing spherical radius (outlined above); no feature of the gravitational structures allows for time dependence given a dU/dt = 0 descriptor. The gravitational enveloping sphere remains static to maintain the constancy of energy. The unstable bosonic structure, an energy-dense structure (~10^{50} Joules/m^3) explodes; the lifetime of the

boson is Heisenberg-limited to ~ $4.2(10)^{-27}$ seconds ($\Delta U\, \Delta t > \hbar/2$). The experimental half-life cited for the bosons is $3(10)^{-25}$ seconds and therefore satisfies the Heisenberg supposed half-life limitation. The energy-propagation (geometric) time across the boson radius is $1.4(10)^{-27}$ seconds, a result comparable in magnitude to the Heisenberg limit. It would appear that a superior geometric form for expressing the lifetimes would be related to a "geometric structural formation time" and, in this case, approximately 73 x Heisenberg limit.

The same calculation for the lifetime of the "Universe-bosonic intermediate-state" equals 0.37 seconds; at a radius of $1.5(10)^6$ meters.

The "intermediate state" condition is one wherein all the original-EM distorted-geometry region has been concentrated into a mimic of the fundamental-particle extremum, the W^-boson mediator-state of "nuclear beta-decay." This distorted "intermediate-state" geometric body is characterized as an "extremum geometric-curvature" body which subsequently and unstably explodes as an electromagnetic (κ_{EM}) energy-dense form.

The post-collapsed or expanding Universe-state is a mimic of the 3-component post-collapsed neutron-state, (a proton plus an electron and a neutrino), mimicked as a (1) gravitational (κ_G) sphere enveloping (2) an EM-like (κ_{EM}) spherical-structure with an accompanying (3) radiation-sphere (κ_{EM}).

The quantitatively modeled energy-density values in the starting condition (starting phase-1) are prescribed from a Friedmann defined gravitational (κ_G) energy-

density state superimposed on a separate-species, equal energy, electromagnetic energy-density state. By mimicking the electron energy-density as an initial condition for the Universe EM component, we fix the Q_{EM}, interpreted as the number of electron-like structures. The present-day CMBR energy-density condition determines the magnitude of the radiation (κ_{EM}) component in the final phase-2. In the nuclear beta-decay phenomenon or mimic, the energy of the neutrino varies as it conserves momentum in the decay process, a structural rearrangement process. The expanding (at velocity c), attenuating electromagnetic-sphere, propagates to the Universe gravitational radial boundary and is reflected upon itself via the phenomenon of total internal reflection (TIR).

Underlying Theory and Field of research

A comprehensive description or model of "matter in the universe" at the fundamental level is proposed. Classical matter and force concepts are posited to be replaced by more "ab initio" or "first principle" energy-producing, geometry-based, structural-model concepts. We have developed a description of matter as a "distorted or warped, non-flat and therefore energy-dense geometric" structure, a geometric-mimic of matter's defining physical characteristics, formulated from a solution of Riemann's geometric equations with both an Electromagnetic (κ_{EM}) and a Gravitational (κ_G)

coupling-constant) (see Appendix for further mathematical and theoretical foundation).

The geometric equations describing such “a region of space”, that is, the “local region in examination” which extends to the “local-origin- r = 0” since no “matter stress-energy-elements” are present, are the 3-dimensional, static, spatial, “Riemannian geometric-curvature equations ($1/r^2$ or $1/r$ by definition)” [1, 2(pp 264)]. We express these geometric-curvature elements in “energy-density” form by applying a composite “stress-energy coupling-constant;” classically a gravitational coupling-constant has been used but here we utilize both the “gravitational coupling-constant form” and the “geometric electromagnetic (EM) form).” With such a posited model, we have produced a geometrically based, 3-dimensional, spatial version of the Riemannian “energy-density (matter)” tensors (Joule/meter^3) as a description of the “stressed” region of space.

Underlying Theory and Example

Similar “static-modeling” was accomplished by Tolman [2, p245] and originally by Schwarzschild [3]; a quote in this regard, “In Einstein's theory of general relativity, the Schwarzschild metric (also known as the Schwarzschild solution) is an exact solution to the Einstein field equations that describes the gravitational field outside a spherical mass, on the assumption that the electric charge of the mass, angular momentum of the mass, and a universal cosmological constant are all

zero. The solution is a useful approximation for describing slowly rotating astronomical objects such as many stars and planets, including Earth and the Sun. It was found by Karl Schwarzschild in 1916, and around the same time independently by Johannes Droste, who published his much more complete and modern-looking discussion only four months after Schwarzschild.

According to **Birkhoff's theorem**, the Schwarzschild metric is the most general spherically symmetric vacuum solution of the Einstein field equations. A Schwarzschild black hole or static black hole is a black hole that has neither electric charge nor angular momentum. A Schwarzschild black hole is described by the Schwarzschild metric and cannot be distinguished from any other Schwarzschild black hole except by its mass."

Clifford's work [4], at least his conceptual "Curved empty space as the building material of the physical world" supposition, or the "Space-theory of Matter", predated Einstein's concepts and work on General Relativity by 40 years.

Additional work in this field continues, some of which is cited in references [5-9].

The present treatment departs from these cited "constructional methods" in that we do not constrain the warped-geometry descriptions to only gravitational-coupling-constant (G/c^4) produced structures.

The mathematical rendering of the spatial (3-dimensioal) "stress-energy-density" equations (energy-density geometric-equations describing the warped spatial

region), as produced by applying a forcing-function or "geometry-to-physical-energy" translation (a coupling-constant in meters per Joule) to the "Riemannian-geometric-curvature equations" [a mathematical description of multi-dimensional (1,2,3,4….) geometric manifolds (also used in general relativity modeling as detailed above)], are applicable for 3-dimensional spatial static (no time-dependent motion or time-dependent characterization) systems. The Riemannian equations are applicable for time-dependent 4-dimensional systems as well as for 2-dimensional systems (think Pythagorean_theorem), and, in the present rendition with the "distinctively-generated metrics, [Appendix equations (SI-4) through (SI-9)]", the equations successfully produce an excellent mathematical-representation, ($1/r^4$), of Newtonian gravitational ($1/r^4$) and electromagnetic ($1/r^4$ and $1/r^6$) energy-density-formulated (think pressure) physical phenomena.

The present resulting geometric description of matter (mass-energy) successfully mimics the classical-physics electromagnetic (EM) and gravitational-field models at large radii of the distorted (warped) region, or energetic-matter region, but the distorted-geometry-regional equations (a description of these same classical forces) depart significantly from "Newtonian (energy-density) $1/r^4$ behavior at small radii"; a Newtonian or Maxwellian model exhibits an infinity at $r = 0$. These pure-geometry-based equations thereby produce a magnetic-field (spin) matter-mimic as well as a weak-field matter-mimic (beta decay and the Fermi-constant {a force constant which describes the magnitude of the strength of the weak fields}); a strong-

field mimic is also mathematically-manifest without an infinity at the origin. There are no infinities or singularities, which are the undesirable hallmarks of pure classical Newtonian and electromagnetic physical models of matter, in these presently, geometrically constructed, structural models [10]. Furthermore, magnetic tensor-elements are an order of magnitude greater than the pure electrical components in the Distorted Geometry model at small radii.

Energy Propagation in an Attenuating Medium

By proposing and characterizing a spatial manifold with absorption [11,11a], modeling the astronomical-redshift-data can be understood as photonic energy-absorption with absorption coefficients of a magnitude comparable to the "descriptor-magnitudes" in the "space-expansion" model (locally unmeasurable). Excerpts from reference [11,11a(corrected 11] and the associated references [12,13] read

"But consideration of the presence of electromagnetic energy sources in the interstellar and intergalactic media (gas in ionic, atomic, and molecular form, as well as charged dust, cosmic rays and plasma-energy sources), that is energy constituents other than conventional gravitational ingredients, as contributors to universe-energy, would lead to potential sources of radiation absorption and inelastic energy loss, however randomly and anisotropically distributed (a reason for the scatter plot cited here) [See the encyclopedic website at **Hubble's law** for a comprehensive discussion and illustration of the experimental measurements (scatter plot) and their aberrations

or peculiarities.]. Radiation propagation in and through terrestrial plasma environments have shown the very absorption phenomena we are here advancing [14-22] and being scalable [23], the phenomena could be incorporated into calculations at extra-galactic, or cosmological, dimensional magnitudes, at least as far as they create a "localized substantive transmission-medium".

In addition, having previously [10] ascribed the attribute of "curvature" (interpreted as a distortional-concept or elastic-characteristic) to the distorted-geometry (DG) manifold, we will also advance a transient collapsing and exploding creation-process for a distorted-geometry universe by {1}, incorporating this additional theorized energy-loss manifold feature, {2}, voiding a theorized "dark energy" component, {3}, incorporating a theorized "dark matter" energy component into our (DG-κ_G) gravitational-energy-component, and {4}, with the inclusion of a geometric (DG-κ_{EM}) component, therefore create a "two-energy-source" description of the Universe.

We enumerate some of the known radiation-energy-loss processes originating from a substantive-medium and postulate a possible phenomenological interpretation of inelastic energy-loss processes as causing radiation-frequency-reduction in the propagating astronomical medium; "*for example in the manner of the* **Compton effect** *(observed that when X-rays of a known wavelength interact with atoms, the X-rays are scattered through an angle theta and emerge at a different wavelength related to θ. Although classical electromagnetism predicted that the wavelength of scattered rays*

should be equal to the initial wavelength, multiple experiments had found that the wavelength of the scattered rays was longer (corresponding to lower energy) than the initial wavelength), or in **Brillouin scattering** *(The result of the interaction between the light-wave and the carrier-deformation wave is that a fraction of the transmitted light-wave changes its momentum (thus its frequency and energy) in preferential directions),*or in **Raman scattering** *(the inelastic scattering of a photon by molecules which are excited to higher vibrational or rotational energy levels), or in the energy-absorbing optoimpulsive- and* **optopiezic-effect** *phenomena*."[24]

Subsequently we construct a phenomenological mathematical representation of the astronomical photon-inelastic-energy-loss-process as a non-linear variation of the established linear energy-loss characterization-functions for particle interactions in nuclear reactions, or in an absorbing medium, as is expressed by the **Bethe formula** for example.

A further phenomenological justification or analytical support for the mathematical absorption structure is given by Herzfeld [13]. In his studies of absorption of ultrasonic waves in gases and liquids, he asserts "When a plane simple harmonic sound wave is propagated through a medium with relaxation, it is necessary to introduce *absorption*."

He further relates on page 57 [13]; "This process of slow energy exchange between different degrees of freedom is the relaxation phenomenon responsible for excess *absorption* of ultrasonic waves in gases ......and in many liquids.

Call E' the momentary value of the internal energy and $E'(T_{tr})$ the value it would have in equilibrium with external degrees of freedom which are at (temperature) T_{tr}. One then assumes the *relaxation equation* [13]

$-dE'/dt = [\ E' - E'(T_{tr})\ ] * 1/\tau$ which contains as individual constant only the relaxation time τ."

2. Theoretical Development

Assumptions and Task

Acceptance of such an absorption-based interpretation of the astronomical data and the expanded two-component coupling-constant, leads to the rationale for the present modeling-undertaking, which limits the composition of the Universe-Energy to a gravitational component (manifest in the coupling-constant $\kappa_G = G\, c^{-4}$) and an electromagnetic component (manifest in the distorted-geometry coupling-constant $\kappa_{EM} = \alpha \frac{\hbar c}{2} \left(\frac{Q}{U_{EM}}\right)^2$).

The model supposes an extended, warped, or distorted, region of the spacetime manifold, said region exhibiting the two energy (distortion) components concentrically. By requiring an energy-conserving (dU/dt = 0) model-descriptor, any instability would only be manifest in the EM component which would then produce the subsequent energy transition processes, modeled as those describable by a distorted-geometry and black body framework. Such a model of the Universe is here

experimentally-suggested by the work of Penzias and Wilson [25] in experimentally and theoretically characterizing the cosmic-microwave-background (CMBR) of the universe; such a Black-Body model has been used in the work cited in references [11] and https://doi.org/10.21203/rs.3.rs-1032260/v11 or [https://archive.org/details/the-transition-dynamics-and-force-constants-of-energy_202206].

The statistical mechanics treatment, the Black-Body modeling or association of the energy-densities with temperature, of an entity the physical size of the universe, also seems warranted. In the "big-Bang" Universe modeling, the CMBR is the "time-cooled," or "expansion extended", left-over radiation from early-generation production (a Universe with a time-expanding spatial manifold).

The present "distorted-geometry model" is essentially the "Curved empty space as the building material of the physical world" supposition of Clifford [4] in 1876 and is the conceptual basis for this "distorted-geometry" modeling. Such a geometric description of localized warping or distorting of the spacetime manifold would seem to constitute a "first-principle" model of the universe achieved only by ascribing to the spatially distorted (warped) region a "material", or "distortable", characteristic.

This work therefore describes a geometrically warped (or distorted) region of space as an energy-mimic of matter appearing in two classical-forms and treated as separate entities, or species, mathematically independent as supported by an equipartition of energies principle.

Underlying existing mathematical framework

For the first phase, we write (U ≡ mass-energy),

(1) $U_{total} \equiv U_{gravitational} + U_{EM} + \cdots$ and set dU/dt = 0 for an energy-conserving description. The time-dependence of the evolving entity is then expressed as

(2) $R_{univ} = 2(\kappa_G + \kappa_{EM})U$ and $dR/dt = 2(\kappa_G\, dU/dt + \kappa_{EM}\, dU/dt + U\, d\kappa_{EM}/dt)$ with dU/dt = 0.

Then dR/dt = ± c = "(+expanding) or (– contracting)" = $2\, U\, d\kappa_{EM}/dt = 2\, U^{-1}$ [KQ 2 Q dQ/dt] and

(3) $$\pm\, c\, t \equiv 2\, U^{-1}\, [\, KQ\, Q^2\,] \quad \text{or} \quad Q^2 = Q0^2 \pm U \frac{ct}{2\, KQ}$$

A black body form as utilized for a spherically emitting entity is

$$\frac{dU}{dt} = -\sigma\, T^4\, 4\pi\, R^2 = -\frac{\rho\, c}{4}\, 4\pi\, R^2$$

where again, U is the body-energy, ρ is the body-energy-density, σ is the Stefan-Boltzmann constant and T is the temperature of the body; such a black body construct was also used in reference [11,11a (corrected 11)] and Transition Dynamics. We have, in the present model, posited the condition of a collapsing sphere with internal energy exchange between the EM components and therefore set $dU_{total}/dt = 0$.

A critical and fundamental element of the "DG" model is the mathematical characterization of the body energy-density (as is the case for black bodies). For this geometrically distorted mimic of matter and space, we write the body energy-density

in the "distorted-geometry (DG)" form, constrained to produce a radially contracting, or expanding, velocity = |c|; i.e., R(first phase) = R1 – c t and R(second phase) = R2 + c t.

(4) $U_G = \rho_{Grav}\, volume_{Grav} \equiv 3(8\pi\kappa_G\,(R_G)^2\,)^{-1}\,\frac{4\pi}{3}\,(R_G)^3 = R_G(2\kappa_G)^{-1}$,

$$U_{EM} = \rho_{EM}\, volume_{EM} \equiv 3(8\pi\kappa_{EM}\,(R_{EM})^3\,)^{-1}\frac{4\pi}{3}(R_{EM})^3 = R_{EM}(2\kappa_{EM})^{-1}\,;$$

The R_G and R_{EM} structure are both Schwarzschildian and DG formulated.

The symbolism used in the coupling constants is, G is the gravitational constant, c is the velocity of light, α is the fine-structure constant, ħ is Planck's constant and Q is the electric-charge of the body. The fine-structure constant α is actually a product-constant and when expressed as such illustrates the geometric structural components of the electromagnetic coupling constant where $\kappa_{EM} = \alpha\,\frac{\hbar c}{2}\left(\frac{Q}{U_{EM}}\right)^2 = \left(\frac{e^2}{4\pi\,\varepsilon o\,\hbar c}\right)\frac{\hbar c}{2}\left(\frac{Q}{U_{EM}}\right)^2 = \left(\frac{e^2}{8\pi\,\varepsilon o}\right)\left(\frac{Q}{U_{EM}}\right)^2$. This breakdown shows explicitly (in this geometric rendering) that the more fundamental "physical-sources" (electric-charge energy (Qe) and mass-energy (U_{EM}) are the causative agents for the "distortion-of-space"; they are expressed mathematically in the coupling-constant strength, both as a $1/r^2$ type of force and as a $1/r^3$ type of force ($1/r^4$ type of energy-density and a $1/r^6$ type of energy-density) and in a "coupled non-linear" manner (see the Appendix for more mathematical detail).

The “Universe-gravitational sphere,” a “distorted-geometry (DG) sphere” is time-independent while the “Universe-electromagnetic (DG) sphere” is initially collapsing at the electromagnetic velocity c.

Statistical mechanics “energy concepts” are manifest as “temperature concepts” while “geometric energy concepts” are manifest as “geometric curvature concepts” or “geometric radial concepts.”

$$\rho = \frac{3\ U}{4\pi\ Rs^3} \quad \text{and} \quad Temp^4 = \rho\ \frac{c}{4\ \sigma}$$

leading to a characterization of temperature as being a geometric curvature ($1/Rs^2$) at the fundamental structural level,

$$Temp^4 = \frac{c}{4\ \sigma}\ \frac{U}{\pi\ Rs^3} = \frac{c}{8\ \pi\ \kappa\ \sigma}\ \frac{1}{Rs^2}\ .$$

In the presently modelled Universe structure, the hotter the temperature of the body, the greater the geometric curvature or the lesser the radius. Therefore, as the body cools its radius will increase and its magnitude is calculated from the above expression.

Results produced (1st and 2nd stages (phases))

We follow the time-dependent energy density quantity ρ_{EM} and utilize the geometric extrema to quantify the t = 0 or starting (birth) condition and the first-phase

termination condition at collapse. We thereby set $\rho_{EM}(0) = \rho_{electron}$ and $\rho_{EM}(@\ \text{collapse}) = \rho_{boson}$. In the DG geometric realm, $Rs_{EM}(t = 0) = 2\ \kappa_{EM}U$ so that

(5) $\rho_{EM}(t) = \frac{3}{8\pi\kappa_{EM}\,(2\ \kappa_{EM}U - ct)^2}$ with $\kappa_{EM} = KQ\frac{Q0^2 \pm U\frac{ct}{2KQ}}{U^2}$.

The energy quantity for the EM component would be equal to the gravitational component or

(6) $\rho_G(t) = \frac{3}{8\pi\kappa_G\,(2\ \kappa_G\ U_G)^2}$ with $\kappa_G = G\,c^{-4}$ and

$$U_{EM} = U_G = \sqrt{\frac{3}{32\ \pi\ \kappa_G{}^3\ \rho\text{critical}}}\ .$$

See Figures 1and 2 for the time-graphed presentation of the Universe-birth conditions, phase-1, and phase-2 energy-density radii, the Grav-Radius and the EM-Radius, and the temperatures and energy-densities. Hole creation, as well as muon, electron, and radiation production occur during this time-interval which is exceptionally **$8.6(10)^4$ seconds (= one day!**).

Figures 3, 4 and 5 show the long-term characteristics of the developing Universe while the creation energy-density of the muon and the Binding energy-density of the “muon in the proton (a posited geometric structure [26])” are displayed in Figure 6.

The mathematics of the modelled gravitational sphere, Eqn.(6), contains only the unknown universe-energy, U_G while the mathematics of the modelled EM sphere contains the unknown U_{EM}, the unknown age-of-the-universe, Age [30], and an

unknown "electric charge" Q. We have posited that the EM-energy-density is specified in the change in R_{EM} and Q. Fitting the phase-2 Universe's posited EM energy component (baryonic energy plus CMBR radiation energy), equation-type (6), to the experimental temperature of the CMBR (abbreviated as TCM measured at t = Age of Universe [31]), determines Q(phase-2), while fitting the gravitational component (with an accepted Friedmann-generated "critical" energy-density, "$\rho_{critical}$" = $8.898(10)^{-10}$ J/m^3) to the Universe's mass-energy (with "zero dark-energy" and "dark-matter" energy considered as gravitational-energy), determines U_G. The internal structure from a Friedmann perspective consists of a gravitational shell with constant-curvature and an internal core-region with contracting and expanding-curvature.

We have also posited an "equipartition-of-energy" concept, a statistical mechanics principle, to set

(7) $\text{Universe Energy} \equiv \text{UNIV} \quad \text{and} \quad \text{U}_{\text{EM}} = \text{U}_{\text{G}} = \frac{\text{UNIV}}{2}.$

The resultant model-parameters thus generated are,

$$\text{Universe Energy} \equiv 2 \text{ x } 7.7\ (10)^{69}\ \text{Joules}\,,$$

$$\text{Q}(\textit{phase\_}1) = 2.1(10)^{55}, \text{ a geometric mimic of the number of electron charges}\,,$$

$$\text{and U(CMBR)Energy} \equiv 5\ (10)^{-5}\ \text{Universe Energy}\,.$$

Matter-energy has been created at some time (?) before the "initial ρ(start) ≥ ρ_electron phase-1 state" but the present post-collapse state ("phase-2") started during the collapsing process. The collapsing **time period** from the **Universe (**ρ_electron-state**)** to the **Universe (**ρ_boson-state**)**, and during the exploding process, a **time**

period from the **Universe (**ρ_boson-state**)** to the **Universe (**ρ_electron-state**)**, can be considered **a "phase-2 creation" time period of $2*4.28(10)^4$ seconds = 0.991 days,** assuming no matter-energy is lost during the explosion! These "times" are the energy propagation times for the EM energy-density to collapse and expand, or the **"phase-2 creation" time** = $2\,[\,R_{U\_elec} - R_{U\_boson}\,]/c = 4\,KQ/c\,[\,\left(\frac{U_{EM}}{(me\,c^2)^4}\right)^{1/3} - \left(\frac{U_{EM}}{(mw\,c^2)^4}\right)^{1/3}]$

= approximately (pp10^7) = $4\,KQ\,\frac{\left(\frac{U_{EM}}{(me\,c^2)^4}\right)^{\frac{1}{3}}}{c} \cong 2R/c$, where $me\,c^2$ is the mass-energy of the electron and $mw\,c^2$ is the mass energy of the boson. In other words, this **"phase-2 creation" time** has mathematically been rendered from "nuclear (fundamental particle) and Universe" physical descriptors.

Relating to the "cosmological principle", the EM sphere-radius, now at $1.27(10)^{26}$ meters, is to be compared with the "Universe-observable-radius", defined as "c*AGE = $1.30(10)^{26}$ meters". This radius-value is approximately equal to the Gravitational sphere-radius now at $1.27(10)^{26}$ meters (calculated with a Friedmann-ρcritical = $8.898(10)^{-10}$ Joules/m^3), however, the radius of this EM portion of the universe is expanding at c meters/sec (until total absorption and/or reflection?).

In the modeling of the physical phenomenon of "beta-decay", the "interaction strength", now labeled the "Fermi constant", has been mathematically and physically described in the "distorted geometry"(DG) model [10] as,

$$\text{"Fermi constant (Joule meter}^3\text{)"} \equiv \text{GF} = \frac{\pi^3}{2}\text{Mw Rw}^3 = \frac{\pi^3}{2}\left(\frac{2}{3}\alpha\right)^{1/3} \hbar\text{c Rw}^2 =$$

$$= \frac{\pi^3}{3}\alpha\,(\hbar\text{c})^3\text{Mw}^{-2}\,,$$

a description in terms of the "physical geometric" descriptors of the W^-boson: Mw is the boson-mass-energy and $\text{Rw} = \left(\frac{2}{3}\alpha\right)^{1/3} \hbar\text{c Mw}^{-1}$ is the boson magnetic-radius.

The gravitational constant "G" can be constructed in physical measures of the Universe and geometrically rendered as

(8) $\mathbf{G \equiv 3\left(\frac{c}{AGE}\right)^2 [8\pi\,\rho critical]^{-1}}$ if $\rho\text{critical} = 8.524\,(10)^{-10}$ Joules/meter^3.

In similar fashion the EM fine structure constant, α, as a geometric elaboration, is

(9) $$\boldsymbol{\alpha^{-1}} \equiv \frac{\mathbf{3}}{\mathbf{4\pi\,(R_{electron})^3\,\rho_{electron}}}\left(\frac{\boldsymbol{\hbar}\mathbf{c}}{\mathbf{R_{electron}}}\right) = (\mathbf{me\ c^2})^{-1}\left(\frac{\boldsymbol{\hbar}\mathbf{c}}{\mathbf{R_{electron}}}\right)$$

where $R_{electron}$ is defined as the "zero" of the "geometric-electromagnetic energy-density" function $(\mathbf{Fd_{14}})^2$ (see Appendix).

Planck's constant from the rendition of the Fermi constant is, on the one hand, $\hbar\text{c} = \text{GF}\,\frac{2}{\pi^3}\left(\frac{2}{3}\alpha\right)^{-1/3}\frac{1}{\text{Rw}^2}$ and on the other hand, $\hbar c = (\alpha)^{-1}\,\text{R}_{\text{electron}}\,\text{M}_{\text{electron}}$; both renditions are manifestations of "geometric-curvature" and functions of other physical constants. In other words, the "physical constants" or "universal constants", G(gravitational), α(fine-structure), GF(weak-interaction) and ℏc are all expressly-defined in terms of "geometric-physical" quantities.

The geometric quantities are “geometric-curvature extrema”, fundamental material-characteristics of the “geometric manifold“, and therefore manifest under energetic-distortion; the “mystery” of the “fine-structure-constant” and other “physical constants” is therefore “understood as “measures of the curvature of space”.

As a refinement of the “starting energy-density values”, if one uses and defines, for the stable U_G, a **Friedmann-ρcritical = $8.524(10)^{-10}$ Joules/m^3**, one calculates **U_{EM} = $7.9(10)^{69}$ Joules**, **R_G = $1.30(10)^{26}$ meter** and **“phase-2 creation” time = 0.997 day!**

This adjustment or perspective can also be viewed in the “variable c” or “variable propagation velocity” or “variable index-of-refraction (energy-density)” context. Alternatively**,** one could adjust the AGE-value to achieve equality between $R_{G.}$ and c*AGE. When the expanding EM sphere reaches the outer edge (R_G) of the gravitational sphere, the energy is reflected (EM transmission from high-index to low-index of refraction) and a collapsing (EM energy concentrating) process begins.

Although “Energy Propagation in an Absorbing Medium” has been shown to be a phenomenon to be considered, we did not explicitly incorporate such in the modeling.

All of the baryonic (**exclusively muon/antimuon-created protons and neutrons,** (**here** are all the anti-muons?), radiation and EM-holes [26, 27, 28]) and gravitational matter-energy (in existence since the beginning (the static gravitational sphere)) has been created by approximately $8.56(10)^4$ seconds, so for an observer

located at the “solar system birth time”, or more importantly the “solar system birthplace” (near the universe center), an “isotropic energy-distribution” would be observed (?) dependent on how the matter created at t = $8.56(10)^4$ seconds has x-velocity distributed itself for $4.34(10)^{17}$ seconds or $13.77(10)^9$ years. Muon creation results in near c-velocity propagation so the streaming (post-muon/electron) wave would propagate behind an EM wave though trailing by not very much. As indicated earlier, muons are considered the building blocks of all EM matter; gravitational energy-densities exhibited in present-day baryonic structures results from constructional-cancellation of the EM energy-density-charges therefore allowing the κ_G coupling constant, independent of charge, to prevail.

The longer-term energy-and-radial-expansion behavior illustrated in Figures 3, 4 and 5, with the original gravitational energy density displayed as ρ_critical, is to be compared with “present day grav-ρ”= $0.951*9.9*10^{-27}$ $c^2 = 8.46$ 10^{-10} Joules/m^3.

Observable energy-densities and time

The present-day daily change in “EM energy-density” is calculated to be

$3Uc/4\pi(ct)^4$ $*(3600*24)$ = $1.7(10)^{-22}$ Joules/meter^3/day or 2 parts in $(10)^{13}$ per day. This change in density can be written as $-\frac{1}{3}\frac{\Delta\rho}{\rho} = \frac{\Delta t}{t}$. Therefore if one can measure, sense, detect or “feel” changes in energy-densities (or time) of parts in 10^{13}/day, one can “feel” and therefore define time.

Any stationary present-day inhabitant of this Universe could observe the "edge of the "electromagnetic energy" distribution" at a radius of $1.30(10)^{26}$ meters since the gravitational-edge is static while the electromagnetic-radial-edge is reflected toward smaller radii.

3. Appendix

Additional fundamental theoretical and mathematical foundations for this undertaking are presented in the Appendix section.

4. Conclusions

It has been shown in the present work that the distorted-space, or distorted geometry (DG), model of matter, can be configured as a "composite gravitational- and EM-energy based structural description of the Universe", that is, geometrically distorted regions of the spacetime manifold can be realized to produce structures satisfying "Universe dimensions and energies" based on "energy conserving, time-based transition dynamics". The dynamics of EM energy production is such as to convert an originally unstable EM geometric structure at U_{EM} = Univ/2 = $7.7(10)^{69}$ Joules into the present-day muonic building-block energy-distribution in **one day**. Earlier successful DG-modeling and mimicking [10] of "Fermi-described beta decay" has been extended to mimic the universe as a description of a collapsing and exploding gravitational and EM energy-bearing entity.

Attributing an absorption coefficient [11,11a] to the gravitational-energy and EM-energy populated geometric-manifold can account for the observed inter-galactic EM-energy frequency shifts and should be considered as a responsible agent for said frequency shifts.

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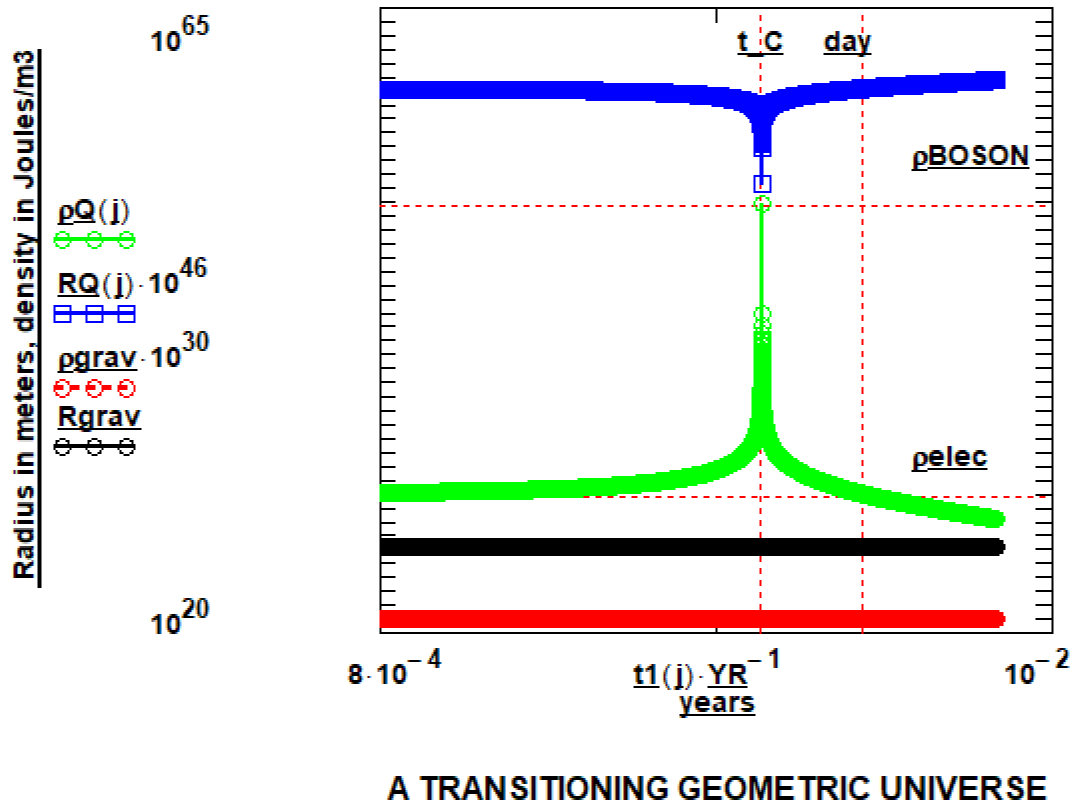

Figure 1. The Universe's gravitational (Rgrav) component non-transitioning-radius and the radius of the EM (RQ) component as a function of time; ordinate in meters and abscissa in years. The contracting and post-collapse expanding electromagnetic energy-density shell is displayed as ρQ in Joules/m^3. The gravitational energy density" = ρgrav with magnitudes of Joules/m^3. The "time notation," "day", is included to highlight the magnitude of the time range to allow "baryonic and

gravitational" energy production; t_C is the time to collapse of the EM sphere. The extremum energy-densities are indicated as ρBOSON and ρelec.

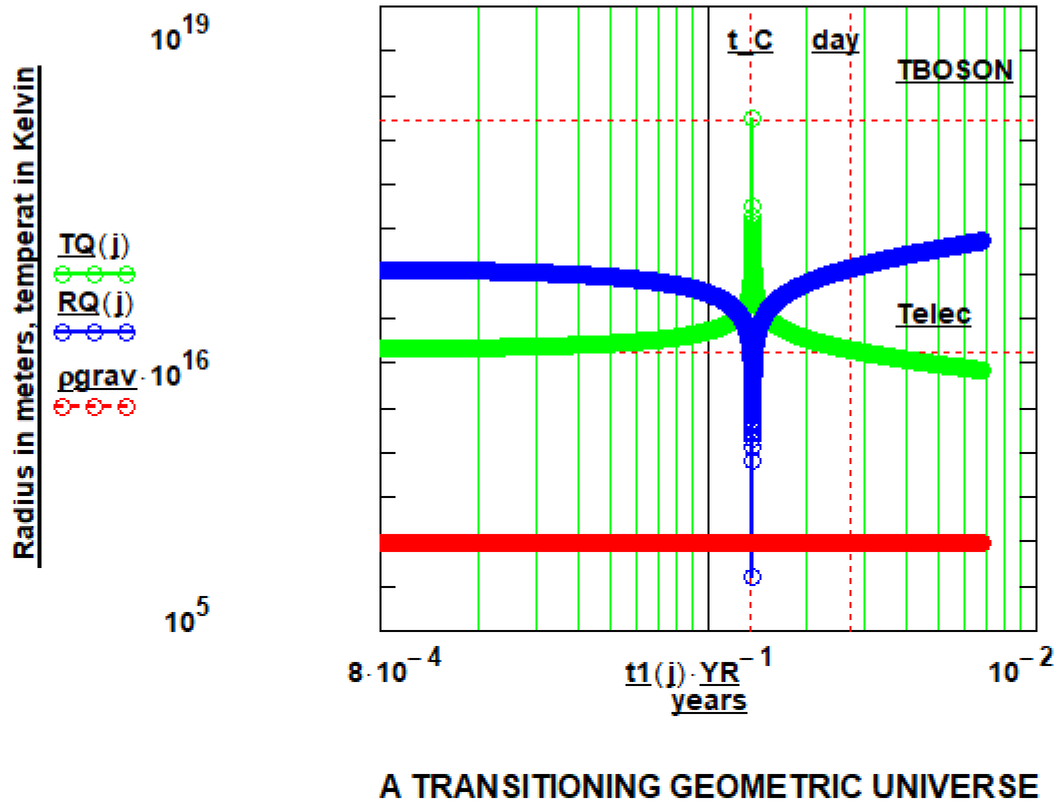

Figure 2. The Universe's gravitational (Rgrav) non-transitioning component as a function of time; the ordinate is in meters and the abscissa in years. The radius of the contracting and post-collapse expanding electromagnetic energy shell is shown as RQ. The temperature of the electromagnetic energy shell is displayed as TQ(j) in Kelvin units with the associated energy-density as ρQ in Joules/m^3 units. The "time notation," "day", is included to highlight the magnitude of the time range to allow "baryonic and gravitational" energy production; t_C is the time to collapse of the EM sphere. The extremum-temperatures are indicated as TBOSON and Telec.

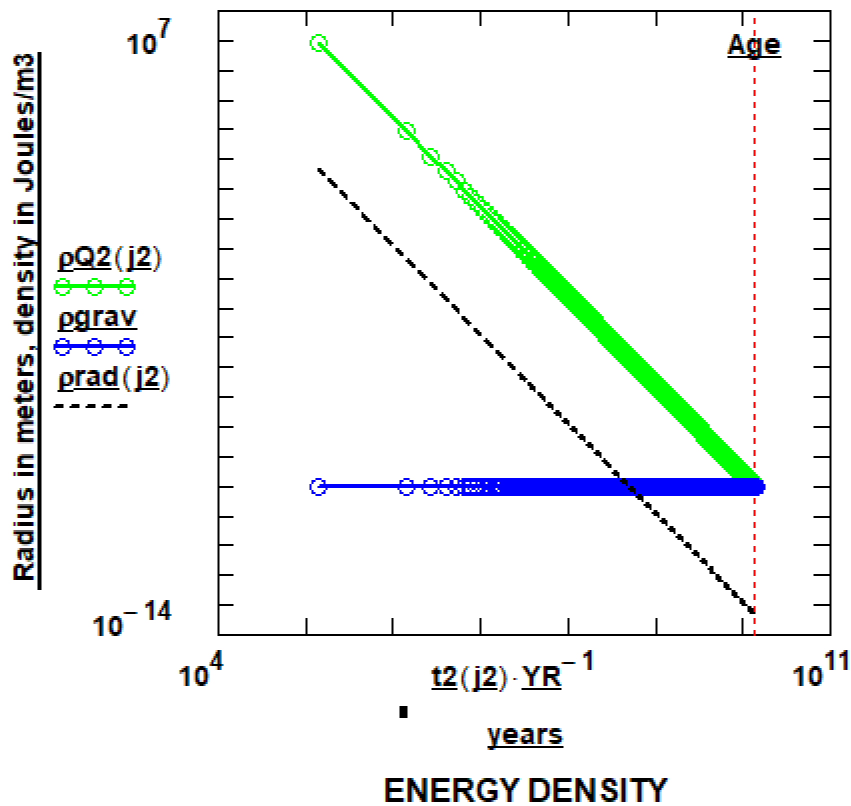

Figure 3. Transitional energy densities are displayed as the Universe's gravitational component (ρG) and the electromagnetic components (ρQ2 and ρrad) and are plotted as a function of time after 10^4 years.

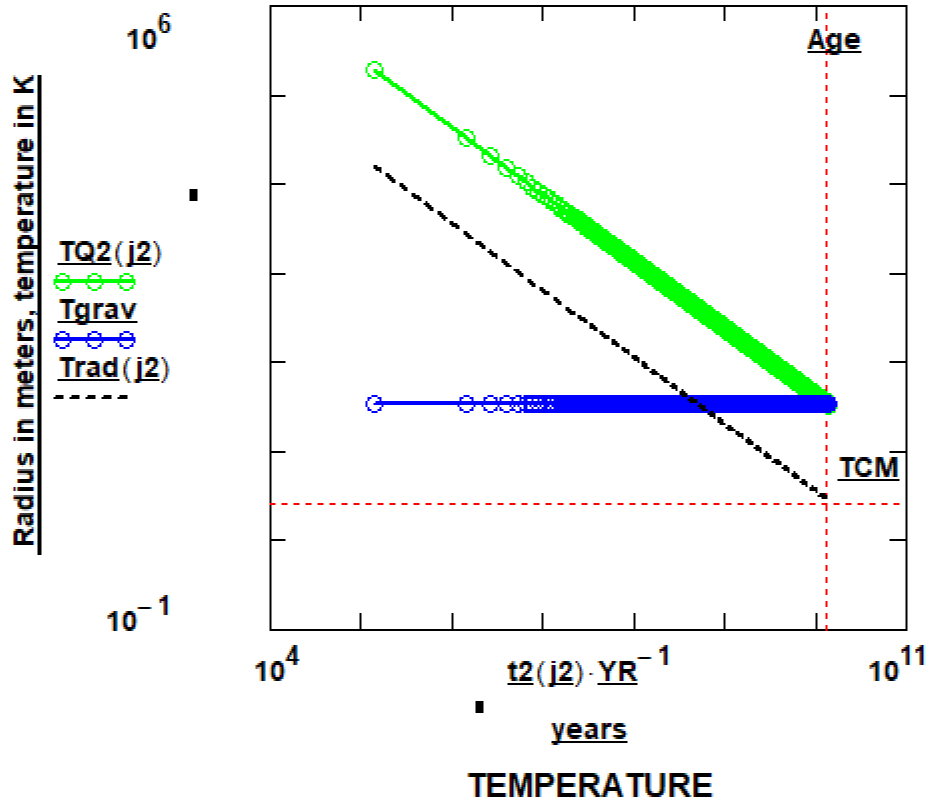

Figure 4. The Universe's gravitational (Tgrav) and electromagnetic (TQ2 and Trad) component-transitioning-temperatures are illustrated as a function of time. The extremely hot EM core has cooled to the presently observed cosmic-microwave-radiation temperature TCMB, a background temperature of 2.726K. The "Universe-time" Age = $13.77(10)^9$ years and the cosmic microwave background CMBR black body temperature is denoted as TCM.

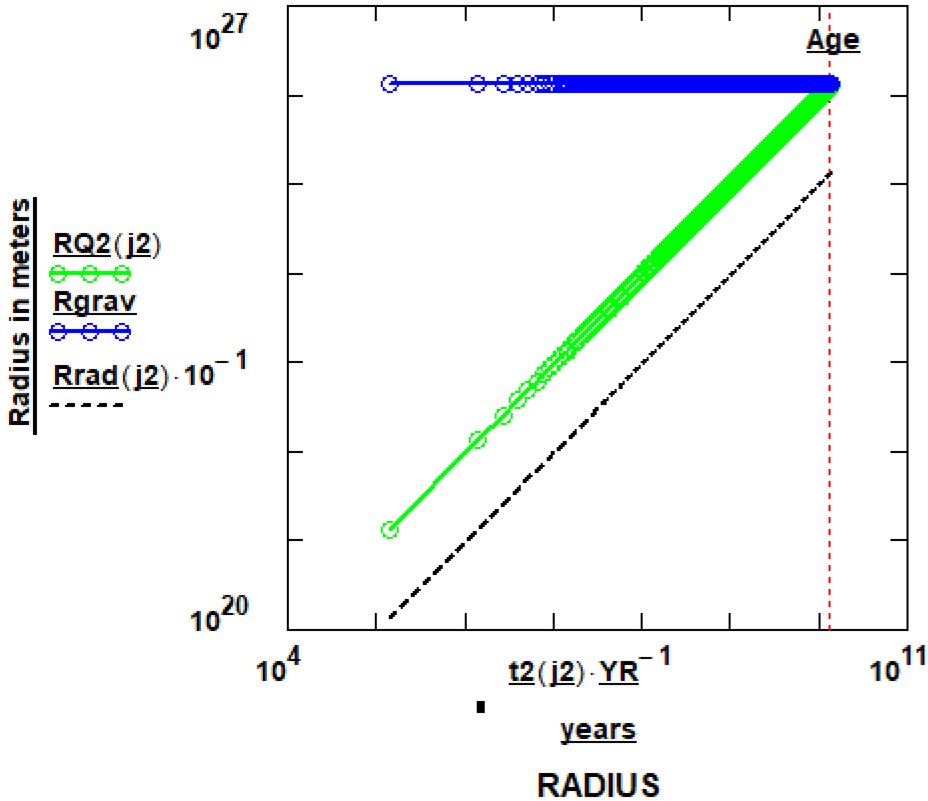

Figure 5. The Universe's gravitational (Rgrav) and electromagnetic (RQ2 and Rrad) component-transitioning radii are plotted as a function of time, ordinate in meters and abscissa in years. The gravitational radius is calculated from the Friedmann critical density, ρ_critical = 8.9 $(10)^{-10}$ Joules/m^3. The radius of the expanding radiation sphere is coincident with the radius of the baryonic- or observable-universe sphere but is offset for display purposes.

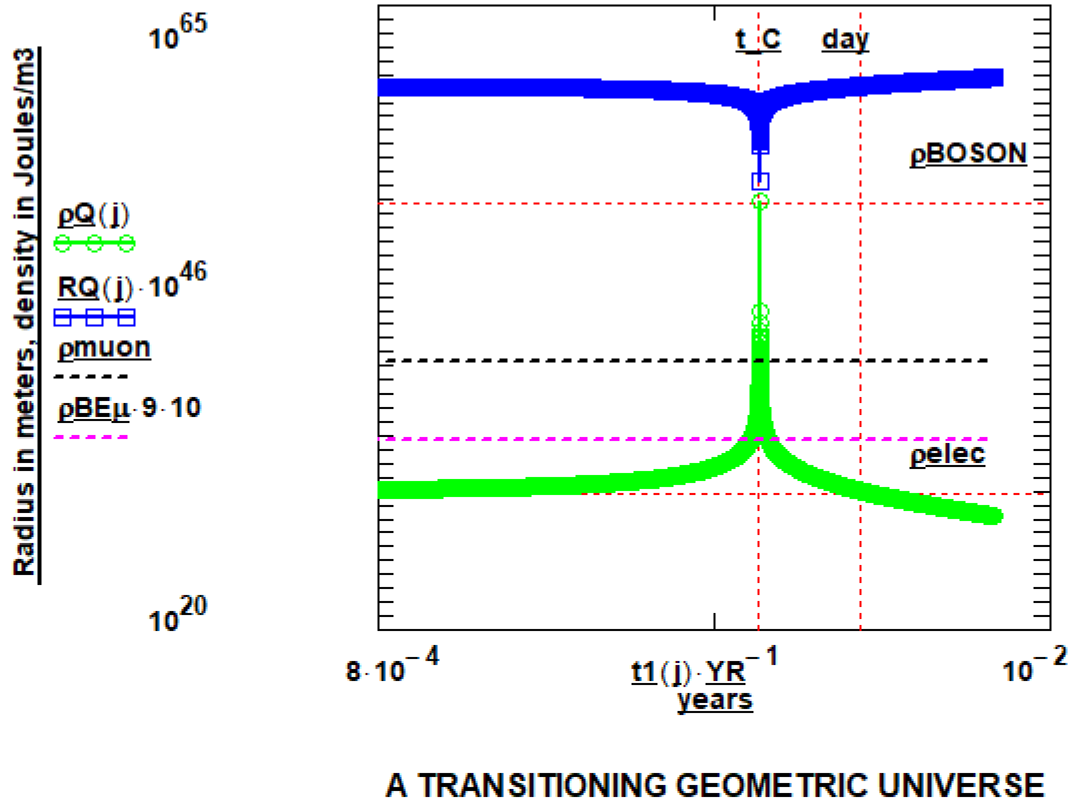

Figure 6. The Universe's radius of the EM (RQ) component as a function of time; ordinate in meters and abscissa in years. The contracting and post-collapse expanding electromagnetic energy-density shell is displayed as ρQ in Joules/m^3. The "time notation," "day", is included to highlight the magnitude of the time range to allow "baryonic and gravitational" energy production; t_C is the time to collapse of the EM sphere. The extremum energy-densities are indicated as ρBOSON and ρelec with a muon-creation energy-density shown as ρmuon and the Binding energy-density of the muons in the posited muon-structured proton shown as ρBEμ.

APPENDIX

The Changing Dynamics of a Universe in Transition

Dale R. Koehler

Similar “static-modeling” was accomplished by Schwarzschild [1](also see Tolman [2, p245] and see a Wikipedia entry [https://en.wikipedia.org/wiki/Schwarzschild_metric]) which is quoted here in this regard: “In Einstein's theory of general relativity, the Schwarzschild metric (also known as the Schwarzschild solution) is an exact solution to the Einstein field equations that describes the gravitational field outside a spherical mass, on the assumption that the electric charge of the mass, angular momentum of the mass, and universal cosmological constant are all zero. The solution is a useful approximation for describing slowly rotating astronomical objects such as many stars and planets, including Earth and the Sun. It was found by Karl Schwarzschild in 1916, and around the same time independently by Johannes Droste, who published his much more complete and modern-looking discussion only four months after Schwarzschild.

According to Birkhoff's theorem , the Schwarzschild metric is the most general spherically symmetric vacuum solution of the Einstein field equations. A Schwarzschild black hole or static black hole is a black hole that has neither electric charge nor angular momentum. A Schwarzschild black hole is described by the Schwarzschild metric, and cannot be distinguished from any other Schwarzschild black hole except by its mass.”

The present geometric description of matter (mass-energy) successfully mimics the classical-physics electromagnetic (EM) and gravitational-field models at large radii of the distorted (warped) region, or energetic-matter region, but the distorted-geometry-regional equations (a description of these same classical forces) depart significantly from Newtonian $1/r^4$ behavior at small radii (an infinity at $r = 0$) and thereby produce a magnetic-field (spin) matter-mimic as well as a weak-field matter-mimic (beta decay and the Fermi-constant, a force-constant which describes the magnitude of the strength of the weak fields); a strong-field mimic is also mathematically-manifest without an infinity at the origin. There are no infinities or singularities, which are the undesirable hallmarks of pure classical Newtonian and electromagnetic physical models of matter, in these presently, geometrically-constructed, structural models [SI-3].

Classically, physical forces have been characterized as independent entities, each with an associated strength (force constant), a Newtonian gravitational-force, an electromagnetic (electric and magnetic)-force, a weak-force describing the physical phenomenon of beta-decay and a strong-force describing short-range-repulsion

effects. These forces are all manifested in the mathematical attributes (force-characteristics or force-constants) of this ONE distorted-geometric form (the solution to the Riemannian geometric tensor equations $\mathbf{Td_4^4}$, $\mathbf{Td_3^3}$, $\mathbf{Td_2^2}$ and $\mathbf{Td_1^1}$), that is, the "metric-solution",

$$\mu'(r) = \frac{2}{(Iu + R0\ C1)\ \mathbf{f(r)}} \frac{u^2}{R0} = \frac{2(\ 1 - u^3)}{(Iu + \gamma)} \frac{u^2}{R0}\ ,$$

where R0 is a "distortion-describing" radius and $Iu(u) = u\left[-1 + \frac{3}{4}u^3 - \frac{3}{7}u^6\right]$; $u \equiv \frac{R0}{r}$.
The geodesic equation for this spherically-symmetric geometry is

$$ds^2 = g_{11}[\ dr^2 + r^2 d\Omega\ ] + g_{44}dt^2 = -\ e^{\mu}[\ dr^2 + r^2 d\Omega\ ] + e^{\nu}dt^2.$$

The "metric-solution" μ' is further expressed fundamentally in the tensor energy-density (pressure) elements $\left[(\mathbf{Fd_{14}})^2,\ \left(\mathbf{Fd_{mag}}\right)^2\ \mathbf{and}\ (\mathbf{Fd_{core}})^{\ 2}\right]$.

The μ' "metric solution" satisfies the "Minkowski" requirement that the "Metric-element coefficient-functions must be consistent with $\mathbf{T_{\mu\nu} = 0}$ (empty spacetime in the vicinity of a source mass) and must approach 1 as r approaches infinity, to become the Minkowski metric in spherical coordinates (the metric should be asymptotic flat.)" This present "distorted geometry" "metric solution" satisfies the Minkowski requirement that

$$\mu'(r) = 0\ \text{ at }\ r = \infty\ ,$$

and also intrinsically satisfies the condition that

$$\mu'(r) = 0\ \text{at}\ \ r = 0\ ,$$

therefore no infinities (dictated by the tensor energy-densities).

This "particular form" of the metric quantity μ'(r) is the solution to the actual metric equation (SI-6d) generated by the "Maxwellian-like" and "material-like" tensor relationship expressed in equation (SI-4):

$$\mu'' + \frac{f'}{f}\mu' + \frac{1}{2f}\ [\ (f - 3)(f - 1) + f\ ]\ \mu'^2 + \frac{2\ \mu'}{r} = 0$$

with $\nu'(r) = [-2 + f(r)]\mu'(r)$ (equation (SI-6a)) and $u \equiv R0/r$. It should be understood that this equation is the fundamental, constraining or restricting and defining differential equation for the metric entity $\mu'(r)$. The metric is not arbitrarily defined, it must satisfy this differential equation in the context of, and as dictated by, the Riemannian geometric equations (SI-4) and (SI-5). The inclusion of an "equation of state" as an additional "necessary or constraining" descriptor of "the distorted

space”, in conjunction with the four Riemann tensor energy-density equations, produces the metric-defining differential equation (SI-6d).

The geometrically-warped structure is constituted by a core-region within which the propagation-velocity, by virtue of the distorted-region metrics, is greater than c and exhibits a “partial light trapping phenomenon”, facilitating and duplicating “black hole” behavior. Warping or distorting our spatial-manifold requires energy but with limits as to the degree of distortion thereby predicting and describing fundamental-electromagnetic-particle structures as well as gravitational (dark-matter, black-hole) structures.

For the presently described spherically symmetric Riemannian-geometric tensors, the Maxwellian electromagnetic tensor and the associated field tensor $\mathbf{F_{1\mu}}$ can be constructed according to equation (SI-1), where the only surviving field tensor components are (following the symbolism and development of Tolman [SI-2]):

$$\mathbf{F_{21} = -\,F_{12}\,,\ F_{13} = -\,F_{31}} \quad \text{and} \quad \mathbf{F_{14} = -\,F_{41}}\,, \qquad \text{i.e.}$$

$$\mathbf{T^{\mu\nu} = -\,g^{\nu\beta}F^{\mu\alpha}F_{\beta\alpha} + \tfrac{1}{4}\,g^{\mu\nu}F^{\alpha\beta}F_{\alpha\beta}} \qquad \text{or} \qquad \mathbf{T^{\mu\mu} = -\,g^{\mu\mu}F^{\mu\alpha}F_{\mu\alpha} + \tfrac{1}{4}\,g^{\mu\mu}F^{\alpha\beta}F_{\alpha\beta}}\,,$$

then

$$\mathbf{T^4_4} = \frac{\left(\mathbf{F_{12}F^{12} + F_{13}F^{13} - F_{14}F^{14}}\right)}{2}, \qquad \mathbf{T^1_1} = \frac{\left(\mathbf{-\,F_{12}F^{12} - F_{13}F^{13} - F_{14}F^{14}}\right)}{2},$$

$$\mathbf{T^2_2} = \frac{\left(\mathbf{-\,F_{12}F^{12} + F_{13}F^{13} + F_{14}F^{14}}\right)}{2} \qquad \text{and} \qquad \mathbf{T^3_3} = \frac{\left(\mathbf{F_{12}F^{12} - F_{13}F^{13} + F_{14}F^{14}}\right)}{2}\ ; \qquad \text{(SI-1)}$$

$$\mathbf{T^4_4 = -\left(T^1_1 + T^2_2 + T^3_3\right)}\,. \qquad \text{(SI-2)}$$

The resultant field quantities are

$$\mathbf{(F_{14})^2 = -\left(T^4_4 + T^1_1\right)g_{11}\,g_{44} = \left(T^2_2 + T^3_3\right)g_{11}\,g_{44}}\,,$$

$$\mathbf{(F_{12})^2 = -\left(T^2_2 + T^1_1\right)g_{11}\,g_{11}} \qquad \text{and} \qquad \mathbf{(F_{13})^2 = -\left(T^3_3 + T^1_1\right)g_{11}\,g_{11}}\,. \qquad \text{(SI-3)}$$

Therefore, we see that the static-spherically-symmetric Maxwellian tensors, (SI-1) and (SI-2), exhibit the same stress and energy relationship as the “equation-of-state geometric-tensors [SI-3],

The present geometric-modeling endeavor, with its Maxwellian-tensor-form mimicking-component, has produced the fundamental and limiting agent for the currently-studied distorted geometry, namely a particular constraining functional relationship between the geometry-defining tensors (for an empty-space geometry, all of the components of the energy-momentum tensor are zero). In characterizing this simple equation (SI-4) as an “equation-of-state” and as a restricting distortional-model tensor relationship, we thereby elicit the metric-defining differential equations for such a family of geometric distortions.

We constrain the modeling therefore by requiring that the descriptive stress-energy tensors satisfy this "constitutive relation" or "equation-of-state" between the temporal and spatial tensor-curvature elements, namely we require

$$\mathbf{Td}_4^4 = -\left(\mathbf{Td}_1^1 + \mathbf{Td}_2^2 + \mathbf{Td}_3^3\right). \qquad \text{(SI-4)}$$

We have introduced the explicit distortional-tensor symbolism **Td** for the geometric quantities. Contrast this perspective with cosmological renditions of geometric curvature structure resulting from "matter" causation, wherein several "equations of state" relating to the "matter" variables ρ (density) and p (pressure) have been forthcoming [SI-4] where $p = \sigma\,\rho$ and where σ varies from -1 to +1.

Since, inherently, in the geometric "equation-of-state" constraint, the requirement that the descriptive stress-energy tensor, **Td**, be Maxwellian in nature, requires that the mimicking process be limited to asymptotically flat-space regions of the manifold since $1/r^2$ field behavior does not adequately describe elementary-particle structural-detail.

The calculational treatment employs the isotropic coordinate description of equation (SI-1) and utilized by Tolman [SI-2], where the system of equations represented by equation (SI-1), is shown more explicitly in equation (SI-5) in mixed tensor form;

$$8\pi\kappa T_1^1 = -e^{-\mu}\left[\frac{\mu'^2}{4} + \frac{\mu'\nu'}{2} + \frac{\mu' + \nu'}{r}\right] + e^{-\nu}\left[\ddot{\mu} + \frac{3}{4}\dot{\mu}^2 - \frac{\dot{\mu}\dot{\nu}}{2}\right],$$

$$8\pi\kappa T_2^2 = -e^{-\mu}\left[\frac{\mu''}{2} + \frac{\nu''}{2} + \frac{\nu'^2}{4} + \frac{\mu' + \nu'}{2r}\right] + e^{-\nu}\left[\ddot{\mu} + \frac{3}{4}\dot{\mu}^2 - \frac{\dot{\mu}\dot{\nu}}{2}\right] = 8\pi\kappa T_3^3,$$

$$8\pi\kappa T_4^4 = -e^{-\mu}\left[\mu'' + \frac{\mu'^2}{4} + \frac{2\mu'}{r}\right] + e^{-\nu}\left[\frac{3}{4}\dot{\mu}^2\right],$$

$$8\pi\kappa T_4^1 = +\,e^{-\mu}\left[\dot{\mu}' - \frac{\dot{\mu}\nu'}{2}\right],$$

$$8\pi\kappa T_1^4 = -e^{-\nu}\left[\dot{\mu}' - \frac{\dot{\mu}\nu'}{2}\right]. \qquad \text{(SI-5)}$$

Metric coupling, that is terms such as μ'ν', are apparent in the fundamental curvature equations. The usual notation, where primes denote differentiation with respect to the radial coordinate r and dots denote differentiation with respect to the time coordinate t, is employed. We are considering the static case (where total differentiation replaces

partial differentiation) as was also used for Schwarzschild's (gravitational) interior and exterior solutions for the model of an incompressible perfect-fluid sphere of constant density surrounded by empty space [SI-1]. In that work a zero-pressure surface-condition and matching and normalization of the interior and exterior metrics at the sphere radius were used as boundary conditions.

Tolman [SI-2] has shown that the energy of a "quasi-static isolated system" can be expressed as "an integral extending only over the occupied space", which we will allow to extend to infinity, and where the total energy of such a sphere is therefore expressed as

$$\mathrm{U(sphere\ total)} = \int_0^\infty \left(T_4^4 - T_1^1 - T_2^2 - T_3^3\right)\sqrt{\left(-g_{11}\right)^3 g_{44}}\, 4\pi\, r^2\, dr = M_{\mathrm{sphere}}\, c^2 \ . \qquad \text{(SI-6)}$$

This mass-energy representation will be used throughout in calculating the distortional mass-energies. The distortional-tensor energy-density amplitudes manifested in these presently calculated geometric representations are both negative and positive, that is, there are both negative energy-density [SI-3] and positive energy-density regions internal to the distortions. Since geometric distortional fields arise from the same energy-density tensors, the negative energy-density geometric regions are also sources of negative energy-density field quantities.

Metric-element coefficient-functions must be consistent with $\mathbf{T}_{\boldsymbol{\mu\nu}} = \mathbf{0}$ (empty spacetime in the vicinity of a source mass) and must approach 1 as r approaches infinity, to become the Minkowski metric in spherical coordinates (the metric should be asymptotic flat)."

The "Kerr" metric is an exact solution of the Einstein equations, generalizing the Schwarzschild metric to represent a "spinning black hole".

The present functional construction can be compared with the Schwarzschild solution [SI-1] in isotropic coordinates where

$$g_{11} \stackrel{\text{def}}{=} -\exp(\mu) = -\left(1 + u(r)\right)^4 \ \text{and}\ g_{44} \stackrel{\text{def}}{=} \exp(\nu) = \left[\frac{1 - u(r)}{1 + u(r)}\right]^2 \ \text{or}$$

$$\nu' = -\left(1 - u(r)\right)^{-1} \mu' \ \text{with}\ u(r) \stackrel{\text{def}}{=} \frac{Rs}{4r}; \quad Rs \stackrel{\text{def}}{=} \text{Schwarzschild radius}\,.$$

Equations (SI-5) can be written in a static system as

$$8\pi\kappa\, \mathbf{Td}_1^1 = -e^{-\mu}\mu' \left[\ \frac{\mu'}{4}(2\,f - 3) + \frac{f - 1}{r}\right],$$

$$8\pi\kappa\, \mathbf{Td}_2^2 = -e^{-\mu}\, \frac{\mu'}{2}\left[\frac{1}{f} f' + \frac{1}{2f}(3 - 2f)\mu' + \frac{1}{r}(1 - f)\right] = 8\pi\kappa\, \mathbf{Td}_3^3\,,$$

$$8\pi\kappa\, \mathbf{Td}_4^4 = e^{-\mu}\mu' \left[\tfrac{1}{f} f' + \tfrac{\mu'}{4f}(2f - 3)(f - 2)\right] . \qquad \text{(SI-6c)}$$

Imposing the "equation of state" relationship (SI-4), in the tensor eq. (SI-6c) for $\mathbf{Td_4^4}$, the "metric differential equation" (SI-6d) is created .

$$\mu'' + \frac{f'}{f}\mu' + \frac{1}{2f}\,[\,(f-3)(f-1)+f\,]\,\mu'^2 + \frac{2\,\mu'}{r} = 0\,. \qquad \text{(SI-6d)}$$

A solution to this equation (SI-6d) is found to be

$$\mu'(r, f(r)) = \frac{2}{r^2 f(r)}\,H(r) \text{ with } H(r)^{-1} = \int \frac{(f-3)(f-1)+f}{(r\,f)^2}\,dr + C1 \overset{\text{def}}{=} \frac{Iu}{R0} + C1 \quad \text{or}$$

$$\text{for } f \equiv f((\text{SI-6b})), \text{ and } n{=}3, \qquad \mu'(r) = \frac{2(1-u^3)}{(Iu + R0\,C1)}\frac{u^2}{R0} =$$

$$= \frac{2(1-u^3)}{(Iu-\gamma)}\frac{u^2}{R0}\left(\begin{array}{c}\text{for}\\ \gamma \overset{\text{def}}{=} -C1\,R0\end{array}\right) \qquad \text{(SI-7)}$$

where

$$Iu(u) = u\left[-1 + \frac{3}{4}u^3 - \frac{3}{7}u^6\right] \text{ and}$$

$$\mu'(r) = 0 \text{ at } r = \infty \text{ and } r = 0\,.$$

"For the special case where f = 1", equation (SI-6d) becomes

$$\frac{d\mu'}{\mu'} + \frac{1}{2}d\mu + \frac{2}{r}dr = 0 \quad \text{with solution} \quad \mu' = \sqrt{B}\,e^{-\frac{\mu}{2}}\,r^{-2}\,.$$

$$\text{Then} \quad e^{\mu} = \frac{B}{4\,r^2} + C \quad \text{and} \quad \nu' = -\mu'\,;$$

$$8\pi\kappa\,\mathbf{Td_4^4} = e^{-\mu}\mu'\left[\frac{\mu'}{4}\right] = \left[\frac{B}{4}\right] r^{-4}\,,$$

$$8\pi\kappa\,\mathbf{Td_1^1} = e^{-\mu}\mu'\left[\frac{\mu'}{4}\right] \quad \text{and}$$

$$8\pi\kappa\,\mathbf{Td_2^2} = -e^{-\mu}\,\frac{\mu'}{4}[\mu'] = 8\pi\kappa\,\mathbf{Td_3^3}\,.$$

This "special case" is a description of a "Maxwellian Perfect-Fluid-like Distortion" with **p0** (pressure***)*** = **ρ0** (mass-energy density)***;*** the definition of the **"**Maxwellian Perfect-Fluid**"** being $-(\mathbf{Td_1^1} + \mathbf{Td_2^2} + \mathbf{Td_3^3}) = \mathbf{p0}$ and $\mathbf{Td_4^4} = \boldsymbol{\rho}\mathbf{0}$. In this case, however, the metric-variables μ', ν' and the energy-density tensor quantities $\mathbf{Td_4^4}$, $\mathbf{Td_3^3}$, $\mathbf{Td_2^2}$ and $\mathbf{Td_1^1}$**,** are all infinite at r = 0.

The μ' metric solution satisfies the "Minkowski" requirement that the "Metric-element coefficient-functions must be consistent with $\mathbf{T_{\mu\nu} = 0}$ (empty spacetime in

the vicinity of a source mass) and must approach 1 as r approaches infinity, to become the Minkowski metric in spherical coordinates (the metric should be asymptotic flat)." Moreover the μ' metric solution, μ'(r) also satisfies the heretofore unsatisfied requirement that μ'(r = 0) = 0 for no infinities.

The metric quantities g_{44} and g_{11} behave consistently with the classical notion of a "Lorentzian-Riemannian smooth manifold with a continuous two-index metric tensor field, non-degenerate at each point of the manifold, which is a basic ingredient of general relativity and other metric theories of gravity"[SI-1].

Both mass and field equations are dominated by the μ' function, but the radial region near the geometric origin requires a precise functional description of the metric quantities g_{44} and g_{11} to accurately characterize the fundamental physical quantities. In fact, as will be shown, the mass-energy quantity is almost exclusively generated by the transition region from "flat-space" to "distorted-space".

Written in the "u" variable form,

$$8\pi\kappa\, \mathbf{Td_1^1} = -e^{-\mu} \frac{1}{(Iu - \gamma)} \left(\frac{u^2}{R0}\right)^2 \left[2\, u^2 + (3\, u^3 - 1)\, \frac{1 - u^3}{(Iu - \gamma)} \right],$$

$$8\pi\kappa\, \mathbf{Td_2^2} = e^{-\mu} \frac{1}{(Iu - \gamma)} \left(\frac{u^2}{R0}\right)^2 \left[4\, u^2 + (3u^3 - 1)\, \frac{(1 - u^3)^2}{(Iu - \gamma)} \right],$$

$$8\pi\kappa\, \mathbf{Td_4^4} = -\, 8\pi\kappa\, (\mathbf{Td_1^1} + \mathbf{2\, Td_2^2}) \;\text{ since }\; \mathbf{Td_3^3} = \mathbf{Td_2^2}$$

or

$$\mathbf{Td_4^4} = e^{-\mu} \frac{1}{8\pi\kappa(Iu - \gamma)} \left(\frac{u^2}{R0}\right)^2 \left[-6\, u^2 - (3u^3 - 1)\, \frac{(2u^3 - 1)(u^3 - 1)}{(Iu - \gamma)} \right] \qquad \text{(SI-8)}$$

and $$8\pi\kappa\, (\mathbf{Td_2^2} + \mathbf{Td_1^1}) = e^{-\mu} \frac{1}{(Iu - \gamma)} \left(\frac{u^2}{R0}\right)^2 \left[2\, u^2 - (3u^3 - 1)\, \frac{(1 - u^3)u^3}{(Iu - \gamma)} \right]$$

leading to

$$(\mathbf{Fd_{14}})^2 = -\, g_{11} g_{44} \left(\mathbf{Td_4^4} + \mathbf{Td_1^1}\right) = g_{11} g_{44} \left(2\, \mathbf{Td_2^2}\right) \qquad \text{and}$$

$$(\mathbf{Fd_{14}})^2 (r \to \infty) \stackrel{\text{def}}{=} \left(\frac{Rs}{2}\right)^2 \frac{2}{8\pi\kappa} \frac{1}{r^4} = \frac{Rs^2}{2} \frac{1}{8\pi\kappa} \frac{1}{r^4} \stackrel{\text{def}}{=} \left(\frac{q}{4\pi\varepsilon o\, r^2}\right)^2 \frac{\varepsilon o}{2}.$$

$$(\mathbf{Fd_{12}})^2 + (\mathbf{Fd_{13}})^2 = \mathbf{2}\, g_{11} g_{11} \left(\frac{\mathbf{Td_4^4 - Td_1^1}}{\mathbf{2}}\right) \stackrel{\text{def}}{=} \mathbf{Fd_{mag}}^2 =$$

$$= -\,2\, g_{11} g_{11} \left(\mathbf{Td}_1^1 + \mathbf{Td}_2^2\right) \quad \text{and}$$

$$(\mathbf{Fd}_{12})^2 + (\mathbf{Fd}_{13})^2 (\mathbf{r} \rightarrow \infty) = 2\ \mathrm{Rs}\ \mathrm{R0}^3 \frac{1}{8\pi\kappa} \frac{1}{\mathrm{r}^6} \stackrel{\text{def}}{=}$$

$$\stackrel{\text{def}}{=} \frac{\mu o}{2} \left(\frac{\mu_{\text{spin}}}{2\pi}\right)^2 \frac{1}{\mathrm{r}^6}$$

where $\mu\_\text{spin} \stackrel{\text{def}}{=} \left(\frac{g_e}{2} \frac{Q\,e}{3M}\right) S\,\hbar$ and $g_e = 2.0023193043\ 6$ (for the electron) .

To illustrate the dependence of the tensor quantities on the metric quantity "near the radial origin", we can show that for "non-infinite" behavior, n must be ≥ 3 ; for example,

$$8\pi\kappa \mathrm{Td}_1^1(\mathrm{r} \rightarrow 0) = \mathrm{e}^{-\mu} \left[\frac{2}{3\, R0^2} (2n+1) u^{2-n}\right] = 0 \ \text{ if n } \geq 3 \ \text{ and } \mathrm{e}^{-\mu} = \mathrm{e}^{\frac{-2}{3}\frac{(2n+1)}{n} u^{-n}} = \mathrm{e}^{-0}\,.$$

After solving for μ and subsequently forming the asymptotic metric form, that is, the expanded large-radius metric, we have equated the distortional-geometric form to a Schwarzschild form with the result that 2/C1 = -Rs. See for comparison the Reisner [SI-5] and Nordstrom [SI-6] metric form constructed in the standard coordinate system for an object with mass "m" and charge "e".

Having constrained the first order large-r (or $r \rightarrow \infty$) metric behavior to the Schwarzschild value $\mathrm{Rs}/\mathrm{r} \stackrel{\text{def}}{=} 2\kappa \frac{\mathrm{Mc}^2}{\mathrm{r}} = -2/(\mathrm{C1}\ \mathrm{r})$, we have ascribed to the model the geometrically generated characteristic of "mass-energy" via an undetermined "microscopic geometrostatic coupling-factor", κ. In this characterization, C1 must also be negative to satisfy the "pseudo-magnetostatic" field constraint elaborated below. Incorporation of the $\mathbf{Fd_{14}}^2 \stackrel{\text{def}}{=} \left(\frac{q}{4\pi\varepsilon o\ r^2}\right)^2 \frac{\varepsilon o}{2}$ term (q is the charge quantity and εo is the permittivity constant) implies an inclusion of the geometrically generated characteristic of "electrostatic charge-energy" in the model (also see Tolman [SI-1]).

Because of the fundamental geometrostatic equation-of-state relationship, the $\mathbf{Td}_2^2$ and $\mathbf{Td}_3^3$ tensor elements are considered constructs of the basis tensors $\mathbf{Td}_4^4$ and $\mathbf{Td}_1^1$, since $\mathbf{Td}_2^2 = \mathbf{Td}_3^3 = -\left(\mathbf{Td}_4^4 + \mathbf{Td}_1^1\right)/2$, and therefore not basis elements themselves. Also for the geometrostatic case, the $\mathbf{Fd_{12}}^2$ and $\mathbf{Fd_{13}}^2$ field quantities are identical and therefore considered functionally addable, at the tensor expression level, to form the single field quantity $\mathbf{Fd_{mag}}^2$. Although there are no "moving" charges in this static spherically symmetric model, the geometric field tensor entity $\left(\mathbf{Fd_{mag}}\right)^2$ is non-zero and therefore both "pseudo-electrostatic" and "pseudo-magnetostatic" distortional

fields are produced. The "pseudo-magnetostatic" distortional-field source-strength is that of a "magnetic-dipole of magnitude to produce the dipole-axial-field".

The electrostatic and magnetostatic constraints (where h = Planck's constant q = particle electric-charge, M = particle mass, μo = permeability constant and c = speed of light ≡ the flat-space propagation-velocity within the geometric manifold), constructed at large radii with r^{-4} and r^{-6} behaviors, have therefore produced (or required for mimicking), in conjunction with the "metric mass-energy" constraint, that the coupling constant be a variable, $\kappa o \stackrel{\text{def}}{=} \kappa = \mu o \left(\frac{\mu_{spin}}{\hbar\, c\, S\, g_e}\right)^2 /2\pi$. Having mimicked both mass-energy and electromagnetic-energy behavior, the coupling constant is a function of both source entities, the electric charge and the mass, but in a combined fashion expressed through the single physical descriptor "μ_spin". These constraints have also determined the geometrostatic quantities, R0 (the distortional-characteristic radius), and C1 (the metric-derivative integration constant). The results are summarized in equation (SI-9); κ, C1 and R0 have been expressed to show more explicitly the charge q and mass M dependence. The three geometric descriptors have been fixed by the two physical descriptors since C1 = C1(κ,M*)* and R0 = R0(κ,M*)*.

$$\kappa o = \frac{\alpha\,\hbar c \left(\frac{Q}{3}\right)^2}{2\left(Mc^2\right)^2} = \frac{\mu o}{2\pi}\left(\frac{\mu\_spin}{\hbar c\; S\; g_e}\right)^2 \ , \quad C1 = -\frac{2}{Rs} = -\frac{1}{\left(\kappa o\; Mc^2\right)} \tag{SI-9}$$

$$\text{and}\quad R0^3 = \frac{1}{3}\left(\hbar c\; S\; g_e\right)^2 \frac{\kappa o}{Mc^2} = \frac{\mu o}{4\pi}\frac{\mu\_spin^2}{Mc^2} \ .$$

A structural-constant is manifested in the 1st mass-moment, R0 Mc^2, or

$$R0\; Mc^2 = \beta\; \hbar c \qquad \text{with} \qquad \beta = \left[\left(S\,\frac{ge}{2}\frac{Q}{3}\right)^2 \alpha\; \frac{2}{3}\right]^{1/3} .$$

Although a classical presentation would not require a "quantization" restriction, we have included this feature to reflect the theoretically used quark concept.

Finally, the geometrostatic sphere "mass-energy" equation must be satisfied for internal integrity and modeling success.

By using the "equation-of-state" relationship for the geometric tensors, the mass equation integrand becomes $2\, \mathbf{Td_4^4} \sqrt{\left(-g_{11}\right)^3 g_{44}}\; 4\pi r^2$, a function of the single geometric tensor element $\mathbf{Td_4^4}$. Writing the tensor component explicitly, we have for the "sphere mass energy", a product of tensor energy-density and the distortional differential volume element.

$$U(\text{sphere}) = \int_0^\infty 2\; Td_4^4 \sqrt{(-g_{11})^3 g_{44}}\; 4\pi\, r^2\, dr \stackrel{\text{def}}{=} M_{sphere}\, c^2$$

$$\text{or} \quad U(\text{sphere}) = \int_0^{\infty} \rho\text{Mass}\, dr \qquad \text{where}$$

$$\rho\text{Mass} = \frac{1}{\text{Iu} - \gamma}\left[\frac{f^{-1}}{\text{Iu} - \gamma}\left(2 - \frac{3}{f}\right)\left(1 - \frac{2}{f}\right) - 6u^2\right]\frac{u^2}{\kappa}\left(|g_{11}|g_{44}\right)^{0.5} \quad \text{and}$$

$$\gamma \overset{\text{def}}{=} -\text{C1 R0} = \frac{2\text{ R0}}{\text{Rs}} = (S\, g_e)^{\frac{2}{3}}\, 2\left[2\,\alpha\text{fs}\left(\frac{Q}{3}\right)^2\right]^{-\frac{2}{3}}.$$

One can express the mass-energy integral in "normalized coordinates";

$$U(\text{sphere}) = Mc^2 \int_0^{\infty} \rho\text{Mass1}\, du \overset{\text{def}}{=} M_{\text{sphere}}c^2 \quad \text{and} \tag{SI-10}$$

$$\rho\text{Mass1} = \frac{\gamma}{\text{Iu} - \gamma}\left[\frac{f^{-1}}{\text{Iu} - \gamma}\left(2 - \frac{3}{f}\right)\left(1 - \frac{2}{f}\right) - 6u^2\right]\left(|g_{11}|\, g_{44}\right)^{0.5}.$$

Then it is seen that the integral must evaluate to unity for equality. Expressing the mass energy-density in this fashion incorporates the effect of the distorted volume on the mass-energy's radial dependence. The sphere-distortion energy is thus seen to be a function of "charge energy" through the integration constant γ and to "spin-energy" through the coupling constant κ.

One comprehensively describes such a geometric distortion family therefore by mimicking a physical "mass" quantity and a "spin" quantity, the "charge" quantity being subsumed in the former "spin" quantity. This should arise from the "two-basis-tensor" geometric foundation. The "mass-energy" quantity is further satisfied internal to the model in the geometrostatic tensor construct of equation (SI-6). In summary, equations (SI-4) through (SI-9) form the equation set for describing the distortional family's "particle-like" characteristics and its associated Maxwellian-like fields. Classically and geometrically, any mass quantity is allowed and describable.

Since the distortional description itself yields a constrained value for the geometrostatic coupling constant, we see that at the mass and charge levels considered here, considerably larger values than the gravitational coupling constant are involved. It is to be noted that the gravitational coupling constant, G/c^4, is approximately 37‒42 orders of magnitude smaller than these geometrostatic Maxwellian-mimicked coupling-constant values.

Gravitational Field Energy density(units of Joules/meter^3,

$$u_G = \frac{G(Mc^2)^2}{8\pi c^4}\frac{1}{r^4} = \kappa_G \frac{(Mc^2)^2}{8\pi r^4};\ \kappa_G \overset{\text{def}}{=} \frac{G}{c^4}.$$

Electrostatic Field Energy density

$$u_E = \frac{\varepsilon o}{2} E^2 = \frac{\epsilon o}{2}\left(\frac{q}{4\pi\varepsilon o}\right)^2 \frac{1}{r^4} = 2\,\kappa o \frac{(Mc^2)^2}{8\pi r^4};\quad \kappa o = \frac{1}{8\pi\,\varepsilon o}\frac{(q)^2}{(Mc^2)^2}\ .$$

Magnetostatic Field Energy density,

$$u_B = \frac{1}{2\mu o} B^2 = \frac{\mu o}{2}\left(\frac{\mu\_spin}{2\pi}\right)^2 \frac{1}{r^6} = 2\,\kappa o \frac{(Mc^2)^2}{8\pi r^6}\frac{(\hbar c\, S\, g_e)^2}{(Mc^2)^2}\ .$$

Geometrostatic Field Energy density,

$$u_{geo} = \text{-}g_{11}g_{44}\left(Td_4^4 + Td_1^1\right) + 2g_{11}g_{11}\left(\frac{Td_4^4 \text{ - } Td_1^1}{2}\right) =$$

$$= \text{as } r\to\infty\ = \kappa_{geo}\frac{(Mc^2)^2}{4\pi r^4}\left\{1 + \frac{(\hbar c\, S\, g_e)^2}{(Mc^2)^2 r^2}\right\};\quad \kappa_{geo} = \kappa o + {}^{\kappa_G}/_2$$

The field equations, in both the EM realm and the gravitational realm (Q = 0), exhibit r^{-6} geometric behavior which we have interpreted as constituting a "magnetic monopole" mimic (what is a "magnetic monopole" ?).

A 2-dimensional plot of this structure is included here to help visualize the "distorted-geometry" model.

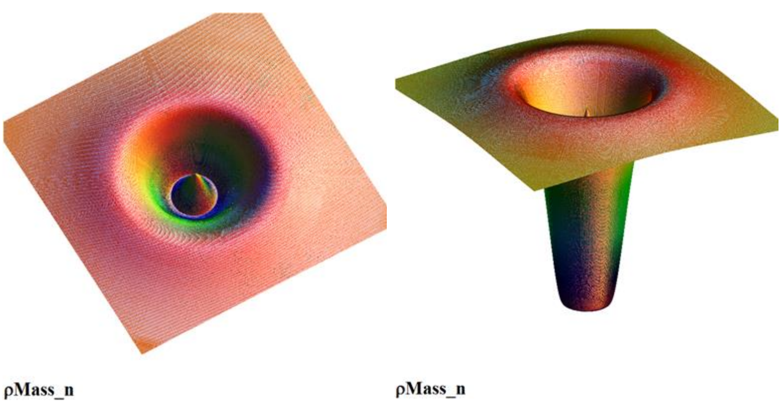

Figure SI-1 Mass-Energy-Density distribution-function surface-plots (two views) (linear radii and logarithmic amplitudes) for the geometric hole distortion.

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